

Tennis Injuries Among German League Players: Investigating Patterns and Epidemiology of Acute and Chronic Injuries

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Purpose: While injuries among elite tennis athletes are extensively documented, a notable research gap exists regarding tennis injuries among club-level players. This study examines tennis injuries in German league players, with a particular emphasis on the impact of racquet properties and court surfaces, distinguishing between chronic and acute injuries.

Patients and Methods: Retrospectively analyzing data from 600 tennis players over a 1.5-year period, a standardized questionnaire covered anthropometrics, injury characteristics, equipment usage, and court surface conditions.

Results: The study identified 1012 tennis-related injuries, averaging 1.7 per player. Acute injuries predominantly affected the lower extremity (56%), with ankle injuries being the most prevalent, and ligaments were the most commonly affected structures (36.4%). Chronic complaints (reported by 364 athletes) focused on the upper extremity (63.2%), primarily tendon injuries (56.8%). Racket properties exhibited no significant impact on chronic upper extremity injuries.

Conclusion: This study highlights a high incidence of acute lower extremity injuries, especially ankle ligament injuries, among German league tennis players. It offers crucial insights for devising targeted injury prevention strategies applicable to amateur, semi-professional, and professional tennis players, despite finding no significant link between racquet material and chronic upper extremity injuries.

Keywords: tennis, injury, epidemiology, court surface, racquet material, ankle, ligament

Introduction

Despite the decline in the popularity of tennis since the 1980s, the German Tennis Federation remains the world's largest Tennis association with over 1.4 million members in 2023.¹ While injury patterns and occurrences in elite athletes have been studied with data provided by the *Association of Tennis Professionals* (ATP) and *Women's Tennis Association* (WTA), there is a lack of research on club level players.^{2,3} The large number of recreational and semi-professional players in Germany underscores the broad engagement in tennis, reinforcing the need to study tennis-related injuries within this group. Given this context, characterizing tennis-related injuries is crucial for preventing long-term disabilities and degenerations resulting from sports injuries.^{4,5} Tennis poses unique physiological challenges due to its complex and repetitive movements, lack of time limits on matches, and repeated explosive bursts of movements, which can lead to a wide array of disabilities.⁶ The impact of equipment on chronic repetitive stress complaints is changing due to major improvements in racquet and equipment technology.⁷ In racket sports unsuitable racquets, strings, and grip techniques have been linked to wrist, elbow, and shoulder injuries.^{8,9} Therefore, finding a connection between repetitive stress complaints of the upper extremity and equipment usage could potentially help prevent injuries in the future.¹⁰⁻¹²

This retrospective cohort study aims to investigate the epidemiology of tennis injuries in German league players, with a particular focus on the impact of racquet properties and court surface on the development of chronic complaints and the occurrence of acute injuries. The study seeks to gain a better understanding of injury mechanisms to identify potential methods for preventing future injuries.

Materials and Methods

Study Design and Participants

This retrospective cohort study analyzed data from 600 tennis players, collected over a period of 1.5 years, with data collection and analysis completed in July 2017. The research involved a detailed examination of anthropometric data, injuries, training habits, equipment usage, court conditions, and stroke techniques using a uniform questionnaire specifically developed for this study. Information was distributed to team captains, and players were encouraged to participate via magazine articles, websites, and social media. Written consent was obtained from all participants, and for those under the age of 18, from their parents or legal guardians. The study encompassed both male and female athletes competing in one of Germany's national tennis leagues. Injuries were defined as time-loss injuries of at least one training session, and exclusion criteria included missing consent, a missing questionnaire, or not belonging to an official team. 1.25% of the players dropped out of the study, the study protocol was approved by the Ethical Review Board of the Medical University of Wuerzburg. The study was conducted in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines, which aim to improve the transparency and quality of reporting in observational research.

Data Collection

The data collection process involved administering a self-created baseline questionnaire that was specifically tailored for this study. This questionnaire was designed to collect comprehensive information about the athletes' demographics, including their height, age, weight, handedness, and backhand technique. The questionnaire was also structured to gather extensive details on training habits, equipment usage, and personal demographics, ensuring a thorough analysis of factors influencing injuries.

Additionally, the players' skill levels were assessed using the German LK-system ("Leistungsklassen-System"), which ranges from 1 to 23, with lower numbers indicating higher skill levels. Specific sections of the questionnaire asked detailed questions about warm-up routines, the usage of bandages and tapes, and the characteristics of the players' rackets, including weight, stringing tension, string material, and vibration dampener usage. Participants were encouraged to provide information about the injury mechanism, diagnosis, and treatment. The exact location and type of both acute and chronic injuries were recorded, critical for identifying injury patterns and developing targeted prevention strategies. The court surface where the incident occurred was documented, the injuries were classified following the methodology outlined by Pluim et al, 2009¹³ to standardize injury categorization.

Statistical Analysis

All statistical analysis was performed using GraphPad Prism v10 (GraphPad, La Jolla, CA, USA). Anthropometrical data was expressed as mean \pm standard deviation (SD), and categorical data was expressed as frequency counts (percentages).

Results

This study included data from 600 tennis athletes and identified a total of 1012 tennis-related injuries during the observation period, resulting in an average of 1.7 injuries per player. The study population was predominantly male (60%), with an average age of 24.8 years, average weight of 72.3 kg, and average height of 179.4 cm. The majority of players (90%) were right-handed and 77.8% preferred a two-handed backhand. Participants of various skill levels, ranging from lower divisional leagues to Germany's highest professional league, the Bundesliga, were included in the study. On average, athletes spent 4.7 hours per week practicing (Table 1).

Acute Injury

The most common affected region in Tennis is the lower extremity, accounting for over 50% of all acute injuries, followed by the upper extremity with 26.4% and trunk with 13.3%. Among acute lower extremity injuries, ankle injuries were the most

Table 1 Anthropometric Data

Participants	600
Male: Female ratio	59:41
Age in years (SD)	24.8 (6.58)
Weight in kg (SD)	72.3 (11.83)
Height in cm (SD)	179.4 (26.3)
Right: Left Handedness ratio	90.2:9.8
Two: One Handed Backhand ratio	77.8:22.2
Experience in years (SD)	16.6 (6.4)
Experience (LK 1–23) (SD)	8.7 (6.01)
Practice in hours per week (SD)	4.7 (4.0)

Abbreviation: LK, Leistungsklasse.

frequent, with a total of 193 injuries (29.8%), making it the most common injury location overall. The thigh followed as the second most frequent injury location, with 85 total injuries (13.1%). Meanwhile, the shoulder was the most injury-prone location in the upper extremity, accounting for 81 injuries (12.5%) (Figure 1).

On closer examination of the affected structures, ligaments were the most commonly affected (36.4%), followed by muscles (31.6%). Tendon (9.6%), cartilage, and meniscus (4.3%) lesions were comparatively rare. There were differences in injury types and afflicted structures depending on the injury location. Ligament lesions were almost exclusive in ankle injuries, while muscular injuries were more frequent in thigh and abdominal injuries. Shoulder, back, and knee injuries involved a more diverse spectrum of structural lesions (Figure 2). Injuries were registered on multiple court surfaces. During the summer, league games in Germany are mainly played on clay, while carpet (with or without granule scattering) is the most common indoor surface. We found a varying distribution of acute injuries across different court surfaces, mainly affecting the ligaments of the ankle. Among all types of injuries sustained on clay courts, ligament injuries accounted for 31%, whereas on granulated and non-granulated carpet, the proportion was higher, with 41.3% and 45.2%, respectively (Figure 3).

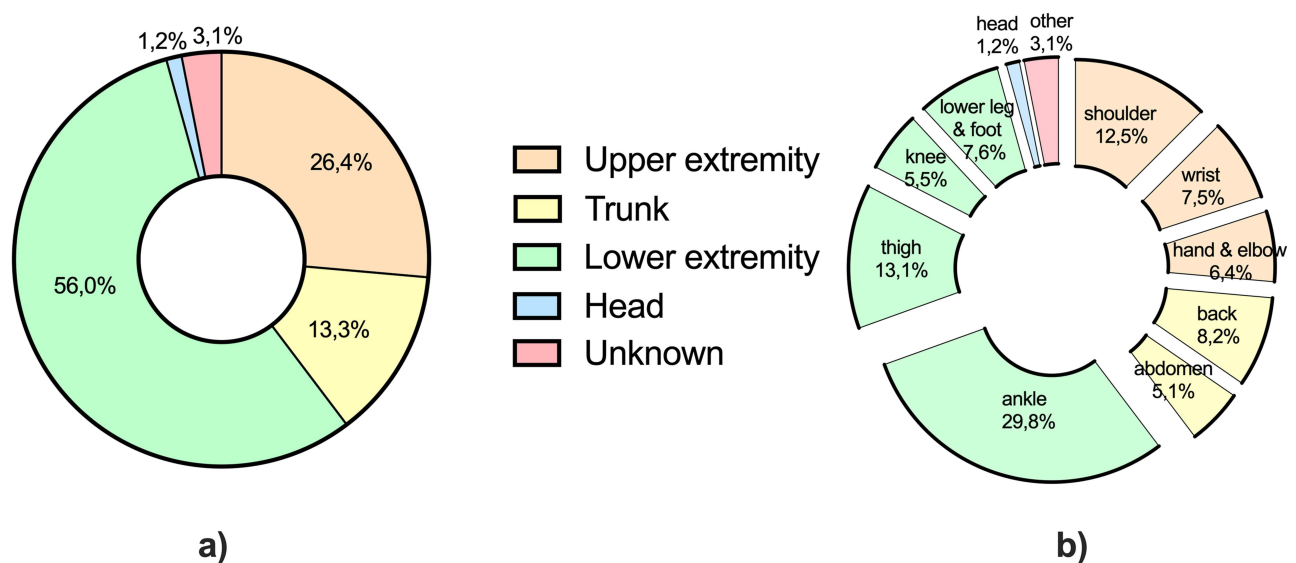


Figure 1 Distribution of acute injury location. (a) Division based on body region; (b) detailed breakdown of anatomical subdivisions. N = 648.

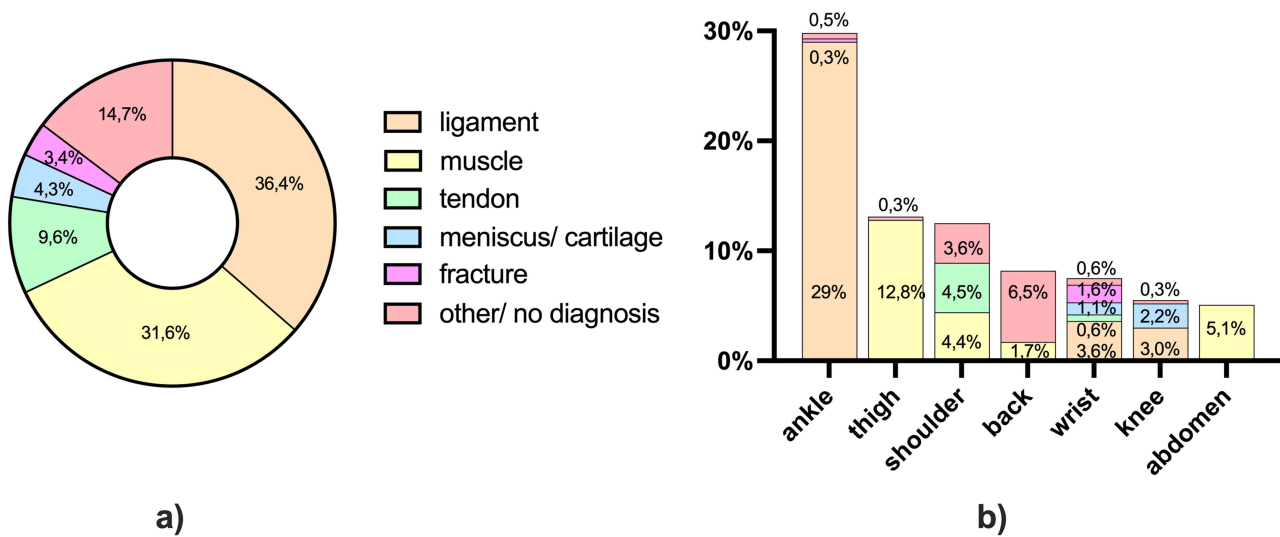


Figure 2 Affected structures in acute injuries. (a) Division based on structure/ diagnosis (b) affected structures based on anatomical location. N = 648.

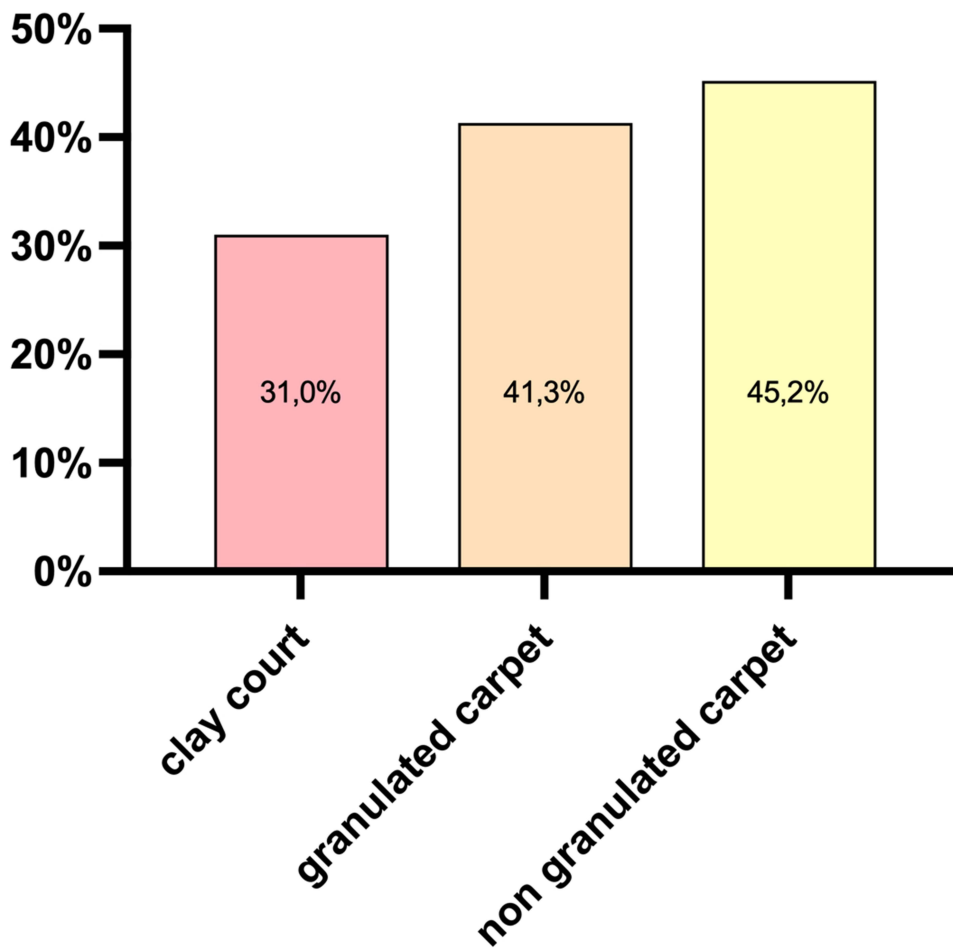


Figure 3 Percentage of acute ligament injuries relative to total injuries on specific playing surfaces. N = 648.

Chronic Injury

During their tennis career, chronic complaints were reported by 364 athletes in this study. The upper extremity was the primary location for these injuries, accounting for 63.2% (n=228) of all cases, with the shoulder (26%) and the elbow (21.1%) being the most frequently affected regions. Chronic back problems were reported in 20.5% of cases, while the lower extremity was affected in 15.8%, with the knee being the most commonly affected region (Figure 4). Ligament injuries were found to be the most common cause of chronic complaints, accounting for 56.8% of cases. In 31.3% of cases, no specific anatomical site was identified as the source of pain, while meniscus and cartilage lesions were responsible for 5.7% of cases (Figure 5). This study also examined whether racket weight, string tension, string material, or the use of a vibration dampener played a role in the development of chronic tendinopathy in the upper extremity. However, no significant differences were found regarding racket material (Tables 2–5).

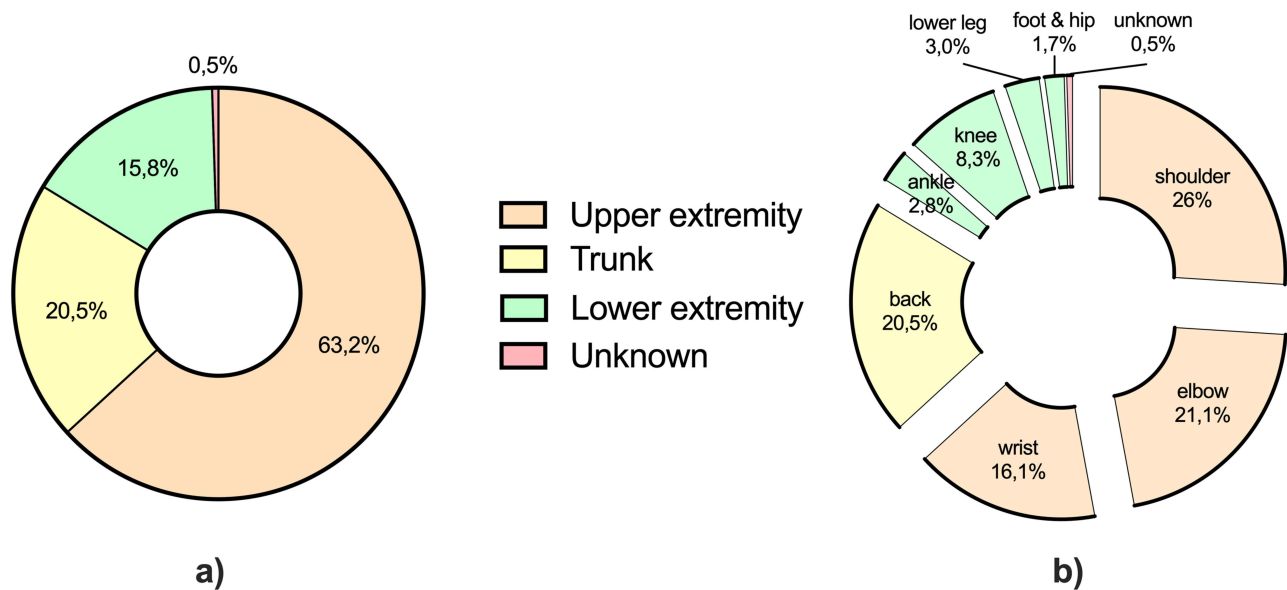


Figure 4 Distribution of chronic injury location. (a) Division based on body region; (b) detailed breakdown of anatomical subdivisions. N = 364.

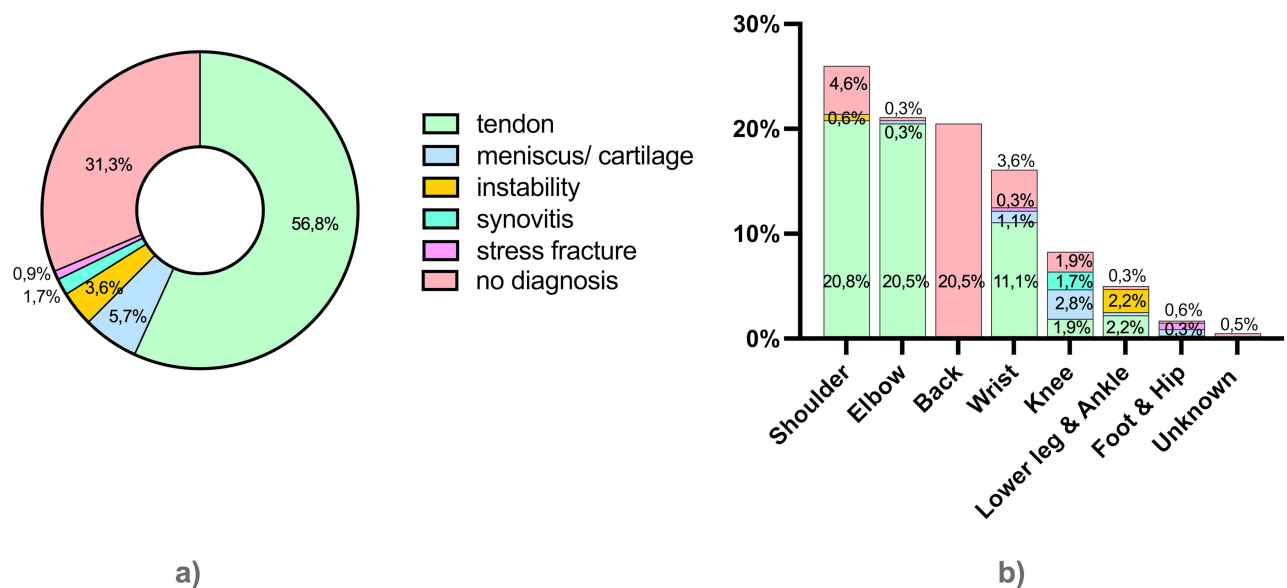


Figure 5 Affected structures in chronic injuries. (a) Division based on structure/ diagnosis (b) affected structures based on anatomical location. N = 364.

Table 2 Relationship Between Racket Weight and the Occurrence of Tendinopathy

		Racket Weight		Total	p-value
		< 300 Grams	> 300 Grams		
Chronic Tendinopathy	n %	78 28.6%	70 30.7%	148 29.5%	
No Chronic Tendinopathy	n %	195 71.4%	158 69.3%	353 70.5%	0.60

Table 3 Relationship Between String Tension and the Occurrence of Tendinopathy

		String Tension		Total	p-value
		< 25 kgs	> 25 kgs		
Chronic Tendinopathy	n %	69 29.2%	77 26.2%	146 27.5%	
No Chronic Tendinopathy	n %	167 70.8%	217 73.8%	384 72.5%	0.44

Table 4 Relationship Between Vibration Dampener Usage and the Occurrence of Tendinopathy

		Vibration Dampener		Total	p-value
		yes	no		
Chronic Tendinopathy	n %	133 27.3%	33 30.8%	167 27.8%	
No Chronic Tendinopathy	n %	354 72.7%	74 69.2%	433 72.2%	0.46

Table 5 Relationship Between String Material Usage and the Occurrence of Tendinopathy

		String Material				Total	p-value
		Natural Gut	Monofilament	Polyfilament	Hybrid		
Chronic Tendinopathy	n %	12 33.3%	85 30.7%	32 25.0%	20 25.0%	149 28.6%	
No Chronic Tendinopathy	n %	24 66.7%	192 69.3%	96 75.0%	60 75.0%	372 71.4%	0.51

Discussion

The present study aimed to investigate injury characteristics and their association with court surface and racket material in recreational to semi-professional Tennis players in Germany. The most common acute injury site was identified as the ankle, while the upper extremity was the most common location for chronic complaints. Our results indicate that racket material did not significantly influence the development of chronic upper extremity injuries. However, we observed

a higher incidence of lower extremity injuries on granulated and non-granulated carpet surfaces compared to clay courts, suggesting a potential influence of court surface on injury location.

Notably, the majority of acute injuries in tennis occur in the lower extremity, with ankle injuries accounting for almost 30% of all recorded injuries in our study population of mainly amateur players (Figure 1). These findings are in line with previous research focusing on injury incidence and location in tennis.^{14–20} Our analysis reveals that ligaments are the most commonly affected structures in tennis-related injuries, closely followed by muscle injuries, with meniscus and tendon damage also notable (Figure 2). This distribution highlights the diversity of tennis injuries, which differ significantly not only by whether they are chronic or acute but also across various anatomical regions. These variations, as corroborated by existing literature, range from overuse injuries like labral tears in the shoulder to acute conditions such as ligament tears and muscle strains in the thigh and knee, highlighting a broad spectrum of injury mechanisms across different anatomical regions.^{21–23}

Several studies have investigated the frequency and location of tennis injuries, with some findings suggesting variations in injury patterns based on equipment usage and court surface. In our study, we observed a notable difference in the incidence of ankle ligament injuries on granulated and non-granulated carpet surfaces compared to clay courts. These findings support the hypothesis that surface characteristics such as high frictional resistance may influence injury risks.^{24–26} While our results contribute valuable insights to the existing body of knowledge, they also highlight the necessity for ongoing research to deepen our understanding of these relationships. Further studies could elucidate more definitive links and assist in the development of targeted injury prevention strategies.

In terms of chronic injuries, upper extremity complaints were the most common in our study population, a finding consistent with previous research.^{14,16,27} Due to the repetitive striking movements and resulting vibrations, overuse injuries are prevalent in tennis. In our population, tendinopathy was the most frequent diagnosis for overuse injuries, with the shoulder being the most commonly affected body region, followed by the elbow and wrist (Figures 3 and 4).

Reducing racquet vibrations appears to be an obvious approach to prevent upper extremity injuries. Despite the fact that over 80% of German league players in this study used a vibration dampener, previous experimental research failed to demonstrate any significant reduction in racquet vibrations resulting from its use.^{28–30} Likewise, our study did not find any correlation between the use of a dampener and a reduction in upper extremity complaints. Moreover, there were no significant differences observed between groups categorized by racket weight (above and below 300 grams), string tension (greater and less than 25 kg), and type of string (rigid and elastic). It is possible that the negligible differences between these groups do not significantly contribute to the development of tendinopathy and associated inflammatory conditions. However it also could be possible, that athletes with already existing issues changed material towards a more gentle material. As numerous authors have suggested, other factors such as playing level, age, and particularly technique may play a more influential role.^{8,31–33}

This study is subject to several limitations due to its design. Firstly, the retrospective approach only included athletes who were willing to participate, potentially excluding a subset of injured players who did not wish to be involved. Additionally, some injuries were self-reported when no physician diagnosis was available. Although efforts were made to clarify and verify this information with participants, the validity of self-reported injuries in tennis remains unclear. Nevertheless, the study aimed to provide a comprehensive epidemiological overview of both acute and chronic injuries across a broad range of amateur, semi-professional, and professional league players. The study successfully classified injuries according to affected body regions and tissue types, and also provided valuable insights into the role of equipment and court surface on the development of chronic and acute injuries, respectively.

Conclusion

This comprehensive study on German league tennis players underscores the high prevalence of acute lower extremity injuries, particularly ankle ligament injuries. Furthermore, the incidence of lower extremity injuries was higher on granulated and non-granulated carpet surfaces compared to clay courts. We did not find a significant correlation between racquet material and chronic upper extremity injuries, suggesting that other factors like playing technique and physical conditioning might be more influential. Despite the extensive data collected, the study encountered limitations inherent in its retrospective design and reliance on self-reported injuries, thereby amplifying the potential for self-report bias. Nonetheless, the insights from our study provide valuable guidance for athletes and coaches in understanding the risk factors associated with tennis-related injuries, especially in relation to court surfaces and equipment use. This knowledge

can inform targeted injury prevention strategies tailored to specific playing conditions and player characteristics, ultimately enhancing athlete performance and well-being. Additionally, our findings underscore the importance of further research in exploring the interaction between equipment, playing surfaces, and injury mechanisms in tennis.

Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethical Review Board of the Medical University of Wuerzburg.

Data Sharing Statement

The data presented in this study is available on request from the corresponding author.

Informed Consent Statement

Written consent was obtained from all participants, and for those under the age of 18, from their parents or legal guardians.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no conflict of interest.

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